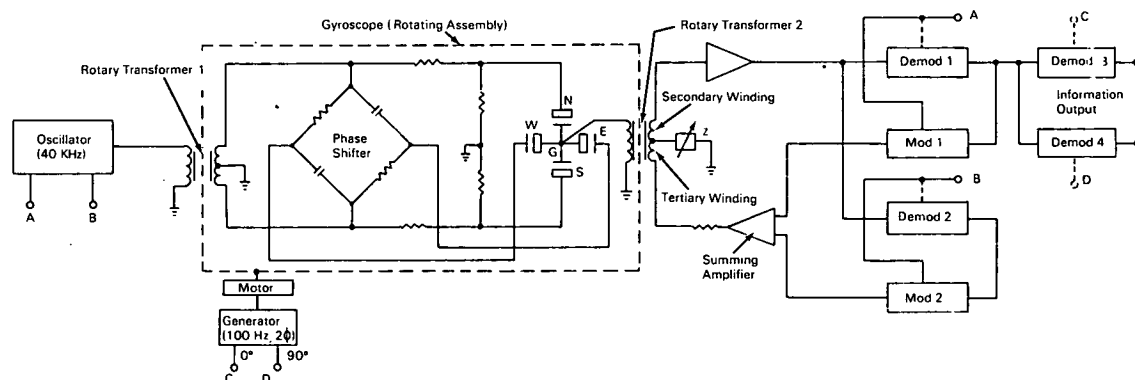


NASA TECH BRIEF



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Compensation Circuit Improves Operation of Inductive Coupling Transformers



The problem:

To eliminate undesirable modulation effects in rotary transformers which transfer electrical energy to and from angular rate transducers on a gyroscope. This type of inductive coupling for energy transfer is free of the frictional effects that occur with brush-slip-ring combinations. However, a means is necessary for compensating the output of such a transformer when variable impedance or variable carrier phase effects occur. The output is generally undesirably modulated at the gyro rotor spin frequency, producing a bias error in the sense output of the system.

The solution:

Circuitry that cancels the error by feeding back compensation signals through a tertiary winding on the stator of the output rotary transformer. The circuitry is particularly useful where relatively high-frequency signals are employed as carriers in conjunction with the rotary transformers.

How it's done:

The system, employing 4 capacitive transducers (for a special fluid tube gyro), includes a 40 kHz oscil-

lator, a 100 Hz generator, a phase shifter and a mod-demod network. Impedance level and narrow bandwidth problems are solved in the system by exciting the transducers, which sense the modulating information signal, at a relatively high frequency, 40 kHz. Without the 40 kHz carrier, the changes in transducer output caused by the 100 Hz spin frequency are too small to detect. The 40 kHz carrier, applied constantly to the transducers, is modulated by the spin frequency and displacement signals.

In operation of the compensation circuit, the 40 Hz oscillator supplies energy through the two sections of rotary transformer 1 to the phase shifter. The spinning element of the gyro is driven by a spin motor, which is coupled to the two-phase 100 Hz generator. Both the oscillator and the generator supply 0° and 90° reference signals, for subsequent use, at terminals, A, B, C, and D.

The phase shifter produces properly phased excitation for the four symmetrically arranged capacitive transducers N, E, S, and W. The 40 kHz carrier signal is applied to the phase shifter, a bridge network composed of two resistors and two capacitors. Thus, 180°

(continued overleaf)

phase-shifted carrier signals excite the N and S transducers, and 90° and 270° phase shifted signals excite the E and W transducers. As the gyroscope is turned about either axis, phased spin frequency modulations are sensed by the transducers. These modulation signals appear at terminal G as a modulated SSB signal at the carrier-plus-spin frequency.

At the output of rotary transformer 2, undesired flux is modulated, causing offset errors in the control system. To generate the cancelling flux, an output is taken from the secondary winding of the rotary transformer output stator winding. It is amplified and then demodulated in demodulators 1 and 2 with respect to the 0° and 90° (A and B) phases of the 40 kHz oscillator voltage. This demodulation produces two spin-frequency signals and two unidirectional voltages. The unidirectional voltages are remodulated in modulators 1 and 2 with the same A and B reference signals. The resulting carrier frequency components are added in the summing amplifier, and the summed error signal is fed to the tertiary winding on the stator of

rotary transformer 2. This cancels the unwanted flux. The effect of mutual coupling of the stator windings on rotary transformer 2 is balanced out by adjustment of impedance Z. The displacement-modulated spin frequency signal then remains. It is demodulated in demodulators 3 and 4 with respect to the 0° and 90° (C and D) reference signals from the 100 Hz generator, yielding the displacement signal or information.

Note:

Inquiries concerning this instrumentation may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B68-10129

Patent status:

No patent action is contemplated by NASA.

Source: Sperry Gyroscope Company
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